

A short essay on posture and movement

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SUMMARY Certain statements concerning the relation of posture and movement which have become traditional are re-examined—in particular, the statement ‘Movement (that is, physiological movement) consists of a series of postures’. The theme of the essay is that posture—that is, postural activity—should be regarded as a function in its own right and not merely as a component of movement and, secondly, that expressions such as ‘a series of postures’ or ‘a change of posture’ are not valid as definitions of physiological movement in general, but describe only movement which is part of the postural function. Voluntary movement consists of much more than a series of postures and its significance, ordinarily, is not postural.

Are posture and movement (particularly voluntary movement) separate functions, or are they different parts of the same function? I see them as distinct, but influential neurological opinion holds the contrary view, and the physiologists seem to be divided.

Certain expressions about their relationship keep turning up in neurological literature through the years and have become almost traditional. Whoever first said ‘Every movement starts from a posture and ends on a posture’ implied that movement and posture had the same physiological basis, and the statement, with this implication, is still current—for example, Keele and Niel (1971). To my mind, however, it contains no argument to justify the implication: posture—that is, postural activity—sustains the movement at its beginning, at its end, and throughout.

Holmes went further when he wrote ‘... that every movement accurately adapted to its aim must not only start from a definite posture and end on a posture, but that the movement itself consists of a series of postures’ (Holmes, 1922), and this last statement, too, is still current; nearly 50 years later in Langworthy’s introduction to *The Sensory Control of Posture and Movement* (1970) it is accepted as a principle that ‘movement is a series of postures’. In slightly different terms Roberts in his *Neurophysiology of Postural Mechanisms* (1967) states that ‘a movement may be thought of as a change of posture’.

The theme of this essay is that posture—that is, postural activity—should be regarded as a function in its own right, with its own physiological and

anatomical basis, and, secondly, that expressions such as ‘a series of postures’ or ‘a change of posture’ are not valid as definitions of physiological movement in general, but describe only movement which is part of the postural function. First, it is necessary to define, or try to define, our terms.

Posture (Postural fixation, postural movement)

Posture as a *state* of the body is defined by two relationships which we separate—that of the body to the ground and that of the parts to each other. Thus we have the upright or standing posture, the lying posture, the sitting posture, each with modifications according to the positions of the limbs and head. Then, the posture of any live thing is almost constantly in motion, and we allow for that by saying that an individual is in the upright posture and walking, or that he is sitting and turning his head, and so on. Again, the upright posture and any posture that is not determined solely by gravity is an active state, since supporting the weight of the body and maintaining its balance on a small base as the parts move relatively to each other are functions that require muscular (and nervous) activity and precise control. In any physiological context this notion of a *supporting activity* against gravity is an inseparable part of the meaning of the word.

Secondly, in physiology the word posture is very frequently used in a derived sense to denote the *function* by which the body is supported—that is, postural activity. This is a coherent and clearly defined function served by a large number of automatic postural mechanisms, which support and balance and ‘right’ the body; it deals with the body’s

relations to *physical forces*. The body has, as it were, an uncanny knowledge of all the relevant laws of mechanics—static and dynamic—quite independent of the psyche. If you stretch your arms out in front of you, thereby creating a weight in front of your line of balance, your head and shoulders move backwards to balance them, and if you have an object in your hands they move back further according to the weight of the object. If, when standing, you raise your left foot, your body, from the right foot upwards, moves to the right so that its centre of gravity comes into a position vertically over the centre of the right foot, and also the upper part of the body tilts to the right and so counterpoises the weight of the left lower limb. Not only do these events happen automatically, but, in general, the subject is not even aware of them. Forces other than gravity are similarly countered; the runner rounding a curve tilts inwards, thereby both counteracting the centrifugal force which tends to carry him straight on and enabling him to direct his footsteps so as to deviate in the desired direction. External forces, too, are automatically resisted, especially horizontal forces, and postural activity is sensitive to the influence of every wind that blows.

The postural *state* of a living body at any moment is the resultant of all the mechanical forces that are acting on it and its reactions to them—including those produced by voluntary and perhaps other movements.

POSTURAL FIXATION

Other postural activities, though they may involve the musculature widely, are predominantly more localised. If the hand is being used at arm's length the limb is supported against gravity by activity of muscles around the shoulder and in the back and down the arm itself of which the subject is quite unaware; the mechanisms of *postural fixation* adjust the musculature to the movements of the hand, posture accompanying movement 'like a shadow' (Ramsay Hunt, 1922).

POSTURAL MOVEMENT

The adjustments of the postural state of the body accompanying head and limb movements may be called *postural movements*, but while they are movements in terms of physics they are brought about by postural reflex mechanisms and, as they maintain the stability of the body, their significance is postural and not motor. These (and also other) postural movements have their own special characteristics: (1) They protect the stability of the body. (2) They are automatic (reflex). (3) They are reactions to physical forces, or preparations to resist physical forces (*v.i.*). (4) They are adjusted in keeping with

the principles of mechanics. (5) In general they are adjustments of the body on itself and do not move it from one place to another; staggering is an exception. (6) Usually they involve muscular activity in almost the whole body. (7) Except for very large movements the subject is unaware of them; in other words they are below the level of consciousness.

Large changes of posture can be made voluntarily, and we are aware of them as voluntary movements and by vision; rising from a chair is a voluntary movement, but there are supporting and balancing activities involved in the act of which we remain unaware; in the diseases, such as Parkinson's disease, in which postural mechanisms are disordered, inability to rise from a chair is usually an early symptom.

Movement (Locomotion, voluntary movement)

To define movement is relatively easy; in terms of physics it is a change of position, and an object in the course of movement passes through a series of positions. However, movement is a very wide term and physiological movements are of different kinds. For the moment, it will be sufficient to consider two varieties in the human subject—locomotion—movement of the body as a whole from one place to another—essentially automatic but under voluntary control—and voluntary movement especially of the upper limbs.

LOCOMOTION

The requirements for human locomotion are, first, antigravity support of the body, then stepping, which is the essential motor element, third, an adequate degree of equilibrium, and, finally, a means of propulsion. Stepping occurs automatically and is excited by throwing the weight of the body over on to one foot so as to release the other and leaning slightly forward, and so the means of propulsion are postural. As antigravity support and equilibrium are also postural functions, all three of the conditions on which stepping, and consequently locomotion, depends are of a postural nature.

Movement of the body as a whole from one place to another can hardly be called a change of posture, but walking and running consist of a series of steps, and each step supports the body and carries it forward. Moreover, if the body is subjected to a sudden push, staggering, consisting of a series of steps, occurs automatically and protects the upright posture. It could be said that stepping is continually preventing the body from falling forward, as is, of course, well seen in the festination of Parkinson's disease. In these various ways stepping serves a postural function. Two other aspects of it are, I

think, significant; the first is the postural nature of the conditions essential for stepping, and the other is that stepping is inborn and automatic (reflex) and that the co-ordinating centre which governs it is not higher than the mid-brain, and so is in close proximity to important postural centres. In addition, each step itself involves quite large postural adjustments. There is, therefore, much to be said for regarding stepping as a postural movement.

VOLUNTARY MOVEMENT

The characteristics of voluntary movement (Jackson's 'least automatic') are very different from those of postural movement. Voluntary movement is pre-meditated, psychologically instigated and directed; the subject is quite aware of it and thinks only of the intended movement 'accurately adapted to its aim' (Holmes), and not of the necessary postural adjustments; the significance of the movement is (in general) not postural—it has nothing to do with supporting or stabilising the body. Far from being inborn and automatic, like stepping, many voluntary movements require a more or less lengthy period of training.

To the extent that the word posture includes the geometrical state of the body at any moment, every voluntary movement must pass through a series of postures—that is, a series of positions with associated supporting activity—but they are not what it consists of; the series of postures provides the changing postural activity which is the supporting element in the total movement, but the volition and the trained co-ordination count for far more than the support, and the greater the skill involved the more is this so.

Much voluntary movement, especially of the upper limbs, is highly skilled movement; if I write on the blackboard I am aware of the activity of my hand, but I have no consciousness of the activity which supports my body and my arm; a champion snooker player makes movements of the greatest delicacy with his hand and arm in spite of many and often awkward variations of bodily posture which may be required of him; a change of posture or 'a series of postures' would be a very inadequate description of such expert movements.

Not only does the voluntary movement consist of much more than a series of postures but in some conditions of disease the movement can still be made when postural support is deficient. Thus, it is common for a patient with disease of the basal ganglia to become unable to hold his head up, especially when he closes his eyes, but he can still raise his head as a voluntary movement. I have described elsewhere (Martin, 1967) the case of a little girl with Wilson's disease whose head fell down immediately when she closed her eyes, but she was quite capable, still with

her eyes closed, of raising her head promptly when asked to do so and also of pushing it back strongly against resistance; against resistance allowance must be made for a possible effect of contact, but still it is evident that she was able to make the voluntary movement of raising her head when postural support was apparently lacking or very inadequate. In neither instance could the voluntary movement be a succession of postures.

OTHER KINDS OF MOVEMENTS

Other kinds of movement, similarly, have nothing to do with supporting the body, and so their significance is not postural. This applies to emotional movement and to movements of expression in general. It applies also to simple reflex movement—that is, other than postural reflexes. The movement of the knee-jerk is not primarily of postural significance; a brisk jerk may provoke a brisk postural reaction, but that is not essential to the original movement. In experimental work, a larger reflex activity such as the scratch reflex may require an important postural adjustment which, as Sherrington pointed out, (1931) is part of the total reflex; in this instance it must begin before the 'scratching' hind foot is raised from the ground, but, as in voluntary movement, the postural activity is only the supporting element in the act and the significance of the whole sequence of movements is not postural. A point of particular interest here is that the postural element precedes, and prepares the posture of the body for the significant movement. The initial postural set is therefore not a 'reaction' to the movement, though it is still adjusted in accordance with the principles of mechanics. Ramsay Hunt (1922) wrote 'Posture follows movement like a shadow' (another traditional statement!); Sherrington preferred 'accompanies' to 'follows' (Sherrington, 1931) on the ground that the posture may be set before or simultaneously with the innervation for the movement (Granit, 1957). The example of the scratch reflex demonstrates this order of events in the quadruped and it is not known whether it may obtain in the voluntary movement of the human subject.

Anatomical considerations

If we turn to the anatomical side, there is considerable evidence that the central mechanisms for posture and for voluntary movement are separate. In the first place, as has just been mentioned, the postural mechanism supporting the head, (with or without vision) may be interrupted by disease while the mechanism for voluntary movement is still intact, and this provides a strong indication that postural activity and voluntary movement have

separate anatomical mechanisms. Secondly, a stereotactic operation on the ventrolateral nucleus of the thalamus may abolish excessive postural activity (rigidity or involuntary movements) leaving voluntary movement normal, and so the pathways for the 'released' postural activity and that for voluntary movement are apparently separate at the site of operation (Martin, 1969). Third, the vestibular mechanism seems to be an exclusively postural receptor, or group of receptors, and under conditions of instability (tilting) it is responsible for exciting large reflex postural adjustments which affect the whole body, and so it must have extensive connections within a postural anatomical system: voluntary movement plays no part in this activity. The mere fact that there is a receptor whose function is limited to the service of posture is evidence that posture has its own anatomical system. Finally, lesions of the basal ganglia cause the abolition of many postural mechanisms without primary impairment of voluntary movement, and so the anatomical systems for posture and for voluntary movement must be at least partly distinct.

Conclusion

It seems to me that posture and voluntary movement are different efferent functions of the brain and that neither can be explained in terms of the other. 'A series of postures' or 'a change of posture' describes posture in motion; as a description of movement each of these expressions is valid only for postural movement (and our peculiar means of locomotion) but not for movement in general, and especially not for voluntary movement, which usually has no postural significance.

Posture is the more fundamental function; it is below the level of consciousness, is concerned with physical forces and the principles of mechanics, and is active in the absence of movement. Posture has no need of voluntary movement, but (within the gravitational field) voluntary movement normally requires the support of posture.

Posture—that is, postural activity—and voluntary movement co-operate intimately and in the present state of knowledge we cannot, within limits, separate them; we cannot, in general, say where, in the course of such movement, the voluntary element ends and postural support begins. As a start in the task of separation it can be taken as a rule of thumb that the part of the total movement of which we are conscious should be regarded as voluntary and that the frankly postural part is below the level of consciousness. In very simple movements the distinction between the two elements is then fairly clear; the young man raising his arms or his foot did so know-

ingly and voluntarily, but the remainder of the total activity, of which he was unconscious, was postural. In all more complex movements, however, there are intermediate elements, from skills which have been cultivated to relatively low physiological activities which are implicated, of which we are not, or only very imperfectly, aware, and it is in this area that separation is, as yet, impossible, and much more sophisticated methods of investigation are required.

Postscript

My attention has been drawn to the experimental work of Lawrence and Kuypers (1968) on the functional organisation of the motor system in the monkey. They found that, after both pyramidal tracts had been divided, pathways descending from the brain stem were capable of directing a wide range of movements of body and limbs, and that interruptions of the ventro-medial and lateral groups of these fibres respectively produced contrasting disturbances of mobility. Two of the conclusions to which their observations led them were as follows:

'The *ventro-medial brain stem pathways* function as the basic system by which the brain exerts control over movement especially concerned with maintenance of erect posture, integrated movements of body and limbs and with directing the course of progression'.

Distal extremity—for example, hand—movements were relatively unaffected by division of these pathways and were much more impaired by division of the lateral group of brain stem fibres, and

'the *cortico-spinal connections* provide the capacity for further fractionation of movements as exemplified by individual finger movements'.

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